ESO Science Archive:
1D spectra publishing process

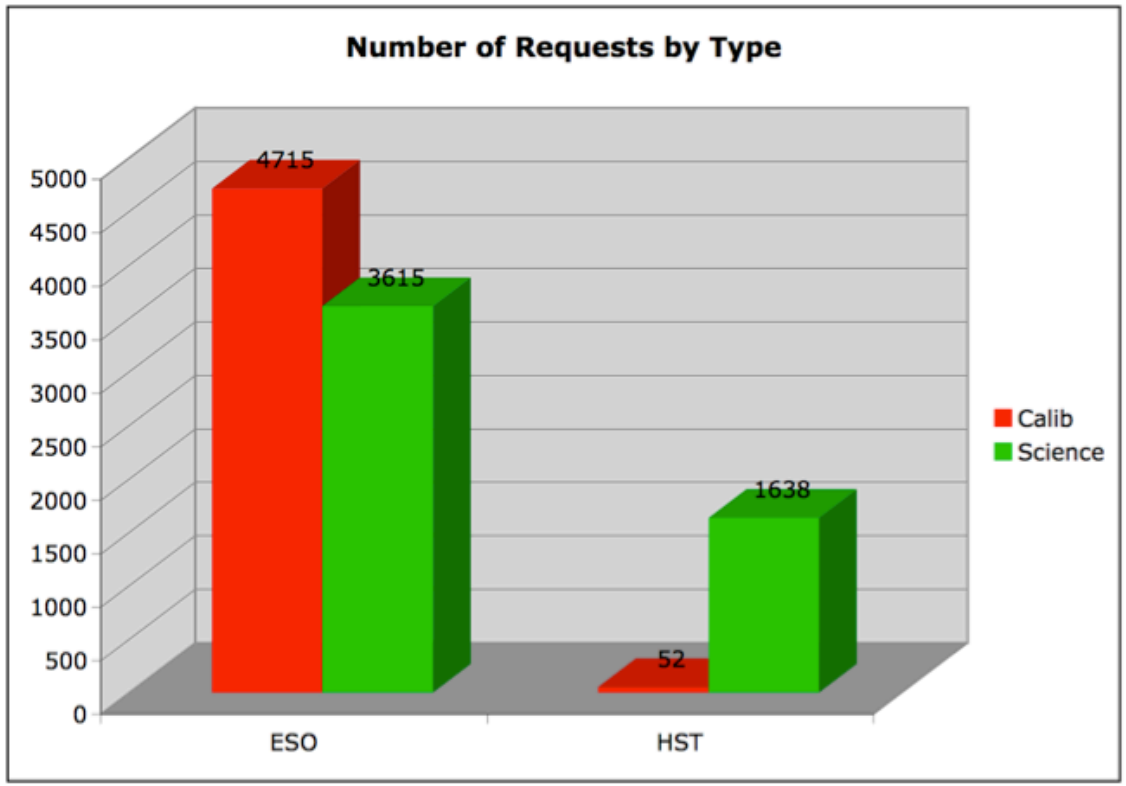
ESO archive evolving from raw to science-ready

Outline

- Introduction:
  - ESO science archive evolution
  - Highlighting problems/solutions
- ESO Science Data Product standard for 1D spectra
- Generating/publishing SDP-compliant spectra?
- SDP VO compliance & usability
- Conclusions

Introduction (1)

- Evolving from raw to science-ready
  - ESO started as a RAW data archive



ESO vs HST/ECF retrievals: comparison in 2005

Introduction (2)

Existing science/advanced data products

Advanced Data Products (ADP)

ADP Release Overview Page

ADP Submission Guidelines

- **FEROS spectroscopic time-series** data releases (August 2010)
- **LABOCA ECDFS Submillimetre Survey** data release (March 2010)
- **VLT/ISAAC HUDF Ks-band imaging** data release (March 2010)
- **GOODS/VIMOS Spectroscopy** final data release (December 2009)
- **GOODS/VIMOS Imaging** data release (April 2009)
- **zCOSMOS** second data release DR2 (October 2008)
- **GaBoDS/WFI** data release update (March 2008)
- **ESO/MVM** data reduction software release (February 2008)
- ***Monitor* NGC 2547/WFI** data release (January 2008)
- **GOODS/FORS2** final data release (October 2007)
- **GOODS/ISAAC** final data release (September 2007)
- **FEROS/HARPS** pipeline processed data query form
- **UVES** reprocessed data and other **Advanced Data Products**
- **30 Doradus/WFI** data release (December 2006)
- **XMM/WFI** Survey Release (September 2005)

Other Public Datasets

ESO Data Releases

- **VISTA** Science Verification
- **APEX-2A** and **LABOCA** Science Verification
- **WFI@2.2m** Science Verification Data
- The **NTT SUSI** Deep Field
- The **SOFI** Infrared images of the **NTT** Deep Field
- QSO survey: large public programme (**VLT UVES**)
- **FORS1** Supernova 1999em data
- **FORS1** - ESSENCE high-z Type Ia Supernovae (April 2005)
- **NACO** Titan April 2004 release
- **GOODS** has lots of ESO VLT (and other data) available **worldwide**

Other Data Releases

- **HST** Data Releases are available here.

Introduction (3)

- Archive user interfaces

Category	Query Forms	Data collection	Data Type	Instruments
LPO Raw Data	**Raw data** query form (all instruments) **Instrument specific** query forms **Direct** retrieval of raw data by file name	All ESO raw data	Various	Many La Silla Paranal instruments
LPO Data Products	**Phase 3 main** query form **Phase 3 imaging** query form **Phase 3 instrument specific** query form	Phase 3 Data Products (ESO Public Surveys)	Currently, Imaging	Currently, VISTA/VIRCAM
	Catalogue Facility query interface	Phase 3 Catalogues [ESO User Portal authentication required also when browsing]	Catalogues	Currently, VISTA/VIRCAM
	Advanced Data Products query form	GOODS (C.Cesarsky)	Imaging, Spectroscopy	FORS2/ISAAC/VIMOS
		zCOSMOS (S.Lilly)	Spectroscopy	VIMOS
		Observation of Corot astroseismologically-selected HD stars (E.Poretti)	Spectroscopy (time series)	FEROS
		UVES reprocessed	Spectroscopy	UVES
		Time-domain survey of NGC 2547 (S.Aigrain)	Imaging	FEROS
	FEROS/HARPS pipeline processed data query form	FEROS/HARPS pipeline processed data	Spectroscopy	FEROS, HARPS
	Science Verification, Commissioning, EIS, etc.	Full list of available data packages	Various	Many
APEX Quick Look Products	**APEX** query form	APEX	Heterodyne, Bolometer	APEX-2A, LABOCA, SABOCA, SHeFI

Introduction (4)

- Archive VO Interfaces (by VOS Dept.)
  - Some VO protocols were introduced:
    - SIAP of DSS images
    - SIAP of (few) selected datasets
    - SSAP of UVES and HARPS pipeline-processed data
  - VirGO archive browser (based on Stellarium)

- Current status of VO Interfaces:
  - VirGO (no longer supported)
  - Existing SIAP and SSAP run unmaintained (no new data)

Problem Domain

- Archive systems & user interfaces
  - Plethora of non-integrated archive subsystems
  - Different metadata (names, units, formats, semantics)
  - Different serialization (some FITS, some TAR)
  - Different database tables
  - Specialised user interfaces
  - Maintenance burden
  - Difficulty to grow
  - Impossibility of providing higher-level services
- On going effort to improve the situation
  - Solutions identified (Archive Roadmap, 2012)
  - Resource-limited effort is on going

Solution domain: stepping stones (1/2)

- Reunification of all archived data products via:
  - Common **Archive Storage** system
    - Has always been common, currently hard drive-based (NGAS, 2001)
  - Unified **Access Control** system (ACE, 2010)
    - Migration of all existing systems to ACE completed in 2012
  - **Phase 3 Science Data Products** standard for Imaging (SDP, 2010)
    - ref. J.Retzlaff's presentation
  - **CalSelector** (2011)
    - Automatic association of calibration files to science data
  - **Ingestion of External Data Products [EDP]** (Phase3, 2011+)
    - Currently: public surveys. Later: large programs, and potentially PIs of other programs willing to provide their data
  - Phase 3 SDP extended to **1D spectra** (2012)

Solution domain: stepping stones (2/2)

- Phase 3 SDP was promoted to **ESO standard** (2012)
  - Most notably, Instrument and Software divisions (pipelines!)

- Management decision **to generate in-house & publish pipeline-process data** of selected instruments (2012/2013)
  - Internal Data Products [**IDP**] will complement the EDPs
  - Starting with UVES-ECHELLE (2013, on-going)
  - **Adopting SDP format!**
    - **Unified ingestion, Common metadata**

- Porting all archive subsytems from **SOLARIS to Linux**
  - Deployment of Request Handler next week will complete the porting of all the main archive components.
  - Completing transition within 2013.

Current Phase 3 Archive Status

- As of now, Phase3 archive contains Imaging only
- Starting 2013 two **integrated** input channels:
  - EDP: External Data Products
  - IDP: Internal Data Products
- During 2013, ingestion of 1D spectra:
  - Spectral EDPs from Spectroscopic Public Surveys
    - PESSTO, S.Smartt (EFOSC2/Optical, SOFI/NIR)
    - GAIAESO, G.Gilmore+S.Randich (FLAMES)
  - Spectral IDPs
    - Starting with UVES-ECHELLE (all data since 2000)
    - Next: GIRAFFE, XSHOOTER
- SDP evolution: IFU/Cubes in 2014.

Part 2

- **Science Data Product format for 1D spectra**

Science Data Product format for 1D spectra

- SDP extended to 1D spectra in 2012
  - After an important study-phase
    - Inputs from various groups (ASG, QC, Science-grade DP,etc)
    - ESO and various ground and space-based instrument data formats were compared.
    - Requirement: spectrum, errors, sky bg in the same file
    - Future proof: support for non equally-sampled arrays
    - Willingness to follow VO standard played a role.
  - The binary table format was chosen.
    - Based on the IVOA SpectrumDM 1.0 FITS format

SDP format for 1D spectra

- Issues
  - IRAF spectroscopic tasks (e.g., onedspec/splot) not capable of handling VO/SDP format
  - ESO instrument calibration pipelines do not (yet) support SDP format
  - Psychologically difficult to move away from the “ground-based 1d IMAGE spectral data format”

SDP format for 1D spectra

Good news:

- IRAF support expected!
  - By next IVOA (Sep 2013), Mike Fitzpatrick has promised to deliver an IRAF external package able to read the VO format
  - Later to be part of IRAF kernel
- SDP is now an ESO-wide standard
  - Instrument pipeline **will** implement the SDP format
  - What to do in the mean time? (see next slide)

Generating 1D spectra in SDP format

- Currently ESO pipelines do not support SDP
  - PIs of Public Surveys need to implement the SDP format by themselves (validation tool comes handy)
  - Internally generated pipeline-processed data need to be converted to SDP (conversion tool)
    - Conversion tool being developed for UVES-ECHELLE
    - User Requirement Document provides recipes for the mapping of the UVES-ECHELLE pipeline products to the SDP format (both keywords and data)
    - Tool developed in Python (PyFITS)
    - Similar effort started for FLAMES/GIRAFFE and HARPS data
    - Additional GIRAFFE complexity: N spectra packed in 1 image

Publishing 1D spectra

- Effort on going to:
  - Extend the metadata extraction process to 1d spectra
  - Extend Phase 3 query forms to 1d spectra
- Publishing systems ready by Q3 2013

Science Data Product format for 1D spectra

- What is the level of **VO compliance & usability** of a SDP-compliant spectrum?
- Luigi's question: What is needed to make a VO spectrum compliant with the ESO SDP format?

VO compliance & usability

Mandatory keywords

- Almost all VO mandatory keywords are present and mandatory as well in the SDP standard;
  - VOCLASS, VOPUB, TITLE, OBJECT, RA, DEC, TMID, TELAPSE, SPEC_VAL, SPEC_BW, {TTYPE,TUTYP,TUNIT,TUCD} for FLUX and WAVE

- Only exception: TDMINn/TDMAXn absent for n>1 ("TDMIN/TDMAX applies to TTYPE1 only")
  - How bad is this? VO tools are quite permissive and would probably be able to still work with SDP spectra.
  - Luigi's happy: providing those extra values is not a problem.

VO compliance & usability

- Recommended VO keywords
  - Missing recommended VO keywords:
    - DS_IDPUB
    - RA/DEC_TARG (confusion: target vs telescope pointing)
    - STAT_ERR (same units as flux)
    - TIME UCD and Unit
    - TIME/SPEC/FLUX-SDIM (dimensional analysis, vospec?)
  - Different names:
    - SDP uses REFERENC (instead of VOREF): bibcode or doi
    - MID-OBS (TSTART)
    - MID-END (TSTOP)
    - FLUXERR [%] (SYS_ERR, which units? not specified in VO)
  - Present as optional keywords in SDP:
    - SPEC_ERR, SPEC_SYE

VO compliance & usability

VO Optional kw name	Default VO value if absent	SDP standard
FLUX_CAL	CALIBRATED	Absent (Misnamed/FLUXCAL)
SPEC_CAL	CALIBRATED	Absent
SKY_CAL	CALIBRATED	Absent
TIME_CAL	CALIBRATED	Absent
TSTART	UNKNOWN	Absent
TSTOP	UNKNOWN	Absent
VOREF	UNKNOWN	Absent (Misnamed REFERENC)
SPECSYS	TOPOCENTER	Mandatory

- VO tools dealing with SDP data will assume potentially wrong values.
  - Example: Phase3 offers a reduced but **not flux-calibrated** spectrum: VO tool does **not** read FLUXCAL, and assumes **CALIBRATED**.

VO compliance & usability

VO TTYPEs	SDP TTYPEs
WAVE/FREQ/ENER	WAVE
FLUX	FLUX
ERR	ERR
BGFLUX	SKYBACK
QUALITY	QUAL
BG_ERR	-
BGQUAL	-

- VO tools will not find SKYBACK and QUAL fields, but could recognise them by the TUTYPn.
- This is the main drawback for (Luigi's) data written in VO-compliant form.

Conclusions

- ESO has put in place a process to:
  - Get the archive content to science-ready status as much as possible: EDP+IDP via Phase 3
    - This coming Saturday, **June 15**, Phase 3 will start receiving PESSTO and GAIAESO spectra! Will be published in Q3.
  - Unify infrastructure to offer better services (SDP is the first fundamental step in the right direction)
  - Generate preview images/spectra for all the scientific products of Phase 3 (on-going, J.Haase ESA/ESO)
  - Have instrument calibration pipeline supporting SDP
- Only then it will be possible to start building a more advanced infrastructure and services
  - improved data model (a la CAOM [CADC]), improved scientific services (VO protocols, footprints, cutouts, etc)